Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development
Vol. 21, Issue 1, 2021
PRINT ISSN 2284-7995, E-ISSN 2285-3952

BIOPREDICTION OF LIVE BODY WEIGHT USING MORPHOMETRIC TRAITS IN AMERICAN STANDARD CHINCHILLA RABBITS

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Abstract

Lack of conventional weighing scales in the rural areas makes the use of body measurements to predict live body weight in rabbits an important study. The objective of this study were to: examine the effects of sex on body weight and other growth traits at eight (8) week, to determine the phenotypic correlations between the body weight and linear body measurements and to predict live body weight of the rabbits using linear body measurements. Measurements were taking on body weight, body length, ear length, tail length, fore arm length, heart girth and abdominal circumference from 61 females and 39 males of American Standard Chinchilla rabbits. The results show that, the values for body weight, body length, ear length, tail length, fore arm length, heart girth and abdominal circumference for female were 1.19 ± 0.02, 31.97 ± 0.25, 10.67 ± 0.13, 9.89 ± 0.19, 15.61 ± 0.14, 21.61 ± 0.17 and 23.75 ± 0.14 respectively, while the corresponding values for male were 0.88 ± 0.04, 28.00 ± 0.37, 10.44 ± 0.25, 8.95 ± 0.14, 14.74 ± 0.17, 19.62± 0.20 and 21.67 ± 0.29. Means were statistically higher ($p<0.05$) in the female compared with male in virtually all the traits considered except in fore arm length. The correlations between body weight and the linear body measurements ranged between -0.011 to 1.000 in the overall population. It is significant in most cases, except in body weight and ear length (-0.156), body weight and face length (- 0.011), heart girth and ear length (-0.046), abdominal circumference and ear length (-0.235). Others are: face length and heart girth (-0.086) and face length and abdominal circumference (-0.216). Coefficient of determination was highest when body length was fitted in the model. When two variables were included in the model highest coefficient of determination was observed in body length and ear length. When all the variables were fitted, the coefficient of determination was the highest. Increased variables in the model showed that, the coefficient of determination also increased. The best predictor of live body weight at eight weeks in American Standard Chinchilla rabbits was body length.

Key words**:** *body weight, body length, abdominal circumference, ear length, fore arm length*

INTRODUCTION

Linear body measurements can give a good description of performance, productivity and carcass quality of animals [9]. Linear body measurements can be used to compare growth in different parts of the body. The various body dimensions develop at different rates and these alterations determine the shape, conformation and body proportion of the animal within a specific period of time. [8], described the inter-relationship between body weight and linear body characters of meat animals as an important application in quantifying body size, shape, growth performance, productivity, and carcass characteristics of animals. Linear body measurements determine the growth of long bones over a period of time. Change in the shape of an animal could readily be an indicator of its live weight and carcass composition. In addition, live weight of an animal predicts its market value [14]. In a similar vein, [3], reported that meat yield increase of an animal is a factor of its genetic improvement of its body weight which depends on the measurement of its growth traits. Therefore, linear measurements have been found very relevant in the prediction of growth in farm animals such as in the case of

poultry [1], goats [10], sheep, cattle and pigs [12]. In an attempt to genetically improve rabbits, [4], conducted a study to assess the relationships among linear body dimensions and body weight in rabbits and crosses. The results indicated that body measurements and weight were generally positive and significant ($p< 0.001$) indicating a very strong inter relationship among different body dimensions. [1] reported very high, positive and highly significant correlation coefficients between the body weight and the measured linear body measurements. Therefore, animals with highly and positively correlated traits in a breeding programme could demonstrate great tendency of achieving increase body weight through body width in the selection index. Selection for growth rate in rabbits depends on its body weight measurement, therefore, selection of genotypes with potential for appreciable body weight is very germane [6]. Growth from different parts of an animal could also be compared with the use of linear body measurements. The performance of an animal is also a factor of body weight and linear body measurements of the animal [17] and [5]. Therefore, improvement of rabbits is important in order to increase their contribution to the much-needed animal protein in Nigeria. Rabbit producers are interested in the relationship that exists between body weight and physical characteristics, since this reflects the performance of the rabbits. According to [11], breeders should be very sure of the relationship that exists between the mentioned parameters before organizing the breeding programmes in order to achieve an optimum combination of body weight and good conformation for maximum economic returns. Relating body weight to linear body measurements is a way of predicting body weight of rabbits. This is relevant especially in rural areas where conventional weighing scales are not available. The objectives of this study were to examine the effects of sex on body weight and other growth traits, to determine the phenotypic correlations between the body weight and linear body measurements and to predict live body weight of the rabbits using linear body measurements

MATERIALS AND METHODS

One-Hundred American Standard Chinchilla rabbits at eight weeks of age comprising of sixty-one (61) females and thirty-nine (39) males were used for this study at Olusegun Agagu University of Science and Technology Teaching and Research Farm, Okitipupa, Ondo State, Nigeria. The animals were housed in individual cages in a well-ventilated Rabbit building. The cages were large enough for free movement. Each cage was fitted with a stainless feeder and drinker. The animals were fed with pelleted food at the rate of 120 g for the adults and between 60 and 100 g for the growers depending on the ages. Clean drinking water was served daily throughout the experimental period. Feeders and drinkers were cleaned daily with soap and water. The cages were cleaned every day from food particles, faeces and other waste. Data on body weight (BW) in kg using a weighing scale and five other linear body measurements in cm [2] were taken according to the procedure of [13] using measuring tape.

Body length (BL): Diagonal distance from the point of the shoulder to the pin bone

Tail length (TL): Measured from the base of the tail to the tip.

Ear length (EL): the distance from the base of attachment of the ear to the head to the tip of the ear.

Fore arm length (FL): is the length from the attachment of the fore arm

Heart girth (HG): measured as body circumference just behind the fore leg.

Abdominal circumference (AC**):** measured as body circumference at the middle of the animal.

The data collected were summarized with descriptive statistics to report the summary statistics and analysis of variance was carried out to examine the effect of sex on the growth traits using [16].

Pearson correlation was used to determine the correlation coefficients among the traits on sex basis. Stepwise multiple regression analysis was used by including the different linear measurements individually and collectively, to identify the best predictor

variables for estimating the body weight. Body weight and regression equation were compared based on coefficient of determination.

The full regression model of the measurements (all the six linear body measurements) was defined as:

$Y = a + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 + b_5X_5 + b_6X_6$

where:

Y = dependent variable (body weight),

a = intercept,

b's = regression coefficients,

X's = independent variables (BL, TL, EL, FL, HG AND AC).

RESULTS AND DISCUSSIONS

Table 1 shows the summary statistics of body weight and linear body measurements of American Standard Chinchilla rabbit at 8 weeks on the basis of sex.

Higher coefficients of variations were observed in the body weight of male (25.86) and female (16.21).

While the least values were observed in abdominal circumference (4.52) in female and heart girth (6.47) in male.

Table 1. Summary statistics of body weight and linear measurements in American Standard chinchilla rabbits

Sex	Variables	Means	SD	N	Min	Max	CV
Female	BW	1.19± 0.02	0.19	61	0.80	1.50	16.21
	BL	31.97± 0.25	1.98	61	28.00	34.00	6.20
	EL	10.67± 0.13	1.05	61	9.00	13.00	9.82
	TL	9.89± 0.19	1.47	61	8.00	13.00	14.87
	FL	15.61± 0.14	1.07	61	14.00	17.00	6.85
	HG	21.61±0.17	1.35	61	19.00	23.00	6.23
	AC	23.75± 0.14	1.07	61	22.00	25.00	4.52
Male	BW	0.88± 0.04	0.23	39	0.70	1.40	25.86
	BL	28.00± 0.37	2.31	39	25.00	33.00	8.23
	EL	10.44± 0.25	1.57	39	9.00	14.00	15.08
	TL	8.95± 0.14	0.85	39	8.00	10.00	9.49
	FL	14.74± 0.17	1.04	39	13.00	17.00	7.08
	HG	19.62± 0.20	1.27	39	18.00	22.00	6.47
	AC	21.67± 0.29	1.81	39	20.00	25.00	8.36

Bw-body weight; Bl-boy length; El-ear length Tl-tail length; Fl-fore arm length; Hg-heart girth; Ac-abdominal circumference

Source: Data generated in a rabbit experiment conducted at Olusegun Agagu Teaching and Research Farm Okitipupa Ondo State, Nigeria.

Table 2 shows the effect of sex on the body weight and the linear body measurements. The estimates were statistically ($p<0.05$) higher in the female compare with male in virtually all the traits considered except in fore arm length in this rabbit breed. The values for body weight, body length, ear length, tail length, fore arm length, heart girth and abdominal circumference for female were 1.19 ± 0.02, 31.97 ± 0.25, 10.67 ± 0.13, 9.89 ± 0.19, 15.61 ± 0.14, 21.61 ± 0.17 and 23.75 ± 0.14 respectively, while the corresponding values for male are 0.88 ± 0.04, 28.00 ± 0.37, 10.44 ± 0.25, 8.95 ± 0.14, 14.74 ± 0.17, 19.62± 0.20 and 21.67 ± 0.29.

Tables 3 and 4 depict the correlation coefficients between body weights and linear measurements, and regression equations for predicting live weight from linear body measurements respectively. The upper diagonal indicates the correlations for males,

while the lower diagonal indicates that of the females.

The results indicate positive and significant correlations between body weight and the linear body measurements ($p<0.05$ and $p<0.001$) and ranged between 0.301 and 0.951 in male while in female, positive and significant correlations were also found between body weight and body length (0.831), tail length (0.184), heart girth (0.788) and abdominal circumference (0.719).

Table 2. Effect of sex on body weight and linear body measurement at 8weeks in American Standard chinchilla rabbits

Variables	Male	Female	Overall
BW	$0.88^{b} \pm 0.04$	$1.19^{a} \pm 0.02$	1.07 ± 0.03
BL	$28.00^{b} \pm 0.37$	$31.97^{a} \pm 0.25$	30.42 ± 0.29
EL	$10.44^{a} \pm 0.25$	$10.67^{a} \pm 0.13$	10.58 ± 0.13
TL	$8.95^{b} \pm 0.14$	$9.89^{a} \pm 0.19$	9.52 ± 0.13
FL	$14.74^{b} \pm 0.17$	$15.61^{a} \pm 0.14$	15.27 ± 0.11
HG	$19.62^{b} \pm 0.20$	$21.61^{a} \pm 0.17$	20.83 ± 0.16
AC	$21.67^{b} \pm 0.29$	$23.75^{a} \pm 0.14$	22.94 ± 0.17

Bw - body weight; Bl - body length; El-ear length Tl-tail length; Fl-fore arm length; Hg-heart girth and Ac-abdominal circumference.

Source: Data generated in a rabbit experiment conducted at Olusegun Agagu Teaching and Research Farm Okitipupa Ondo State, Nigeria.

The correlations among the body linear measurements in the males ranged between 0.108 and 0.951 while it ranged in females between -0.235 and 0.681.

The correlations between the body weights and the linear body measurements in the overall population was observed to range between -0.011 to 1.000 as shown in Table 3. The results show that the correlations between the body weights and the linear body measurements is significant in most cases, except in body weight and ear length (-0.156), body weight and face length (- 0.011), heart girth and ear length (-0.046), abdominal circumference and ear length (-0.235). Others are: face length and heart girth (-0.086) and face length and abdominal circumference (-0.216).

Table 3. Phenotypic correlation among the body weight and linear body measurements in male and female America standard Chinchilla rabbits

	BW	BL	EL	TL	FL	HG	AC
BW	1.000	0.951***	0.884***	0.301*	0.930***	0.648***	0.851***
BL	0.831***	1.000	0.892***	0.108	0.874***	0.674***	0.851***
EL	-0.156	0.163	1.000	0.411**	0.895***	0.748***	0.856***
TL	0.184	0.530**	0.483**	1.000	0.341*	0.396*	0.288
FL	-0.011	0.505**	0.627***	0.681***	1.000	0.638***	0.816***
HG	0.788***	0.570**	-0.046	0.086	-0.086	1.000	0.870***
AC	0.719***	0.489**	-0.235	0.024	-0.216	0.877***	1.000

Bw-body weight; Bl-boy length; El-ear length Tl-tail length; Fl-fore arm length; Hg-heart girth; Ac-abdominal circumference

Source: Data generated in a rabbit experiment conducted at Olusegun Agagu Teaching and Research Farm Okitipupa Ondo State, Nigeria.

The significant effect ($p<0.05$) observed in virtually all the variables considered in this study was in favour of female which indicates sexual dimorphism. This is in line with the observation of [13] who reported that at eight weeks female New Zealand White, Dutch and

their crosses were statistically higher in body weight and linear body measurements compared to the males. The body weight of 1.19 kg observed for female in this study is higher to what was reported (856.25 g and 544.64 g) for Dutch and New Zealand White female rabbit by [13]. This could be attributed to differences in breed. Similar trend was observed in male body weight and all other variables considered. The overall abdominal circumference (22.94 cm) observed in this study is lower to the report of [7] at age twenty weeks (23.59 cm). The overall estimates for all the parameters considered are lower to the reports of [18] for the same breed.

The phenotypic correlations between body weight and the linear body measurements in males are all significant, positive and moderate to highly correlated which indicate pleiotropy i.e. improvement in any of the variables will lead to improvement in the body weight. This observation is similar to the report of [7] and [15]. Similar trends were also observed in females. As the coefficient of determination increased in each regression model, residual mean square decreased. In regression model with one variable, body length had the highest coefficient of determination (0.858) which means that 85.8% change in body weight could be attributed to change in body length.

Table 4. Regression equations for predicting live weight from linear body measurements in America standard chinchilla rabbit

Predictive equations	A	b1	b2	b3	b4	b5	b6	MSE	R^2
Y= a+b1BL	-1.444	0.8083						0.097	0.858
Y= a+b2EL	0.290		0.073					0.239	0.135
Y= a+b3TL	0.417			0.069				0.240	0.130
Y= a+b4FL	-0.677				0.114			0.221	0.258
Y= a+b5HG	-1.611					0.129		0.146	0.676
Y= a+b6AC	-1.829						0.126	0.132	0.735
Y= a+b1BL+ b2EL	-1.383	0.086	-0.014					0.096	0.862
Y= a+b1BL+ b3TL	-1.383	0.089		-0.026				0.093	0.872
Y= a+b1BL+ b4FL	-1.021	0.100			-0.062			0.083	0.897
Y= a+b1BL+ b5HG	-1.770	0.064				0.043		0.086	0.889
Y= a+b1BL+ b6AC	-1.830	0.060					0.047	0.084	0.895
Y= a+b2EL+ b3TL	0.058		0.053	0.048				0.233	0.187
Y= a+b2EL+ b4FL	-0.674		0.002		0.113			0.222	0.258
Y= a+b2EL+ b5HG	-1.750		0.025			0.123		0.144	0.690
Y= a+b2EL+ b6AC	-1.849		0.005				0.125	0.133	0.736
Y= a+b3TL+ b4FL	-0.654			0.013	0.105			0.222	0.261
Y= a+b3TL+ b5HG	-1.687			0.019		0.123		0.145	0.685
Y= a+b3TL+ b6AC	-1.936			0.024			0.121	0.129	0.749
Y= a+b4FL+ b5HG	-2.170				0.055	0.115		0.134	0.729
Y= a+b4FL+ b6AC	-2.136				0.036		0.116	0.128	0.755
Y= a+b5HG+ b6AC	-1.894					0.043	0.090	0.129	0.750
Y= a+ b1BL+ b2EL+ b3TL+ b4FL+ b5HG+ b6AC	-1.387	0.080	0.010	-0.004	-0.055	0.006	0.029	0.075	0.919

a-Intercept, b2 – regression, b3 - coefficient
Source: Data generated in a rabbit experiment conducted at Olusegun Agagu Teaching and Research Farm Okitipupa Ondo State, Nigeria.

In regression model with one variable, body length had the highest coefficient of determination (0.858) which means that 85.8% change in body weight could be attributed to change in body length.

Higher coefficient of determinations observed in this study among multiple regression models shows that the actual weight is better predicted by multiple models. In conclusion, the live body weight in American Standard rabbits could be better predicted by simple model (body length) and multiple regression models.

CONCLUSIONS

The growth traits of American standard chinchilla rabbit favoured female than male at eight weeks of age and the best predictor of

live bodyweight by simple model was body length and multiple regression model.

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